

Muon Ring as an Anti-Cyclotron

R. Godang, D. Summers
University of Mississippi

June 28-29, 2004
BNL, New York

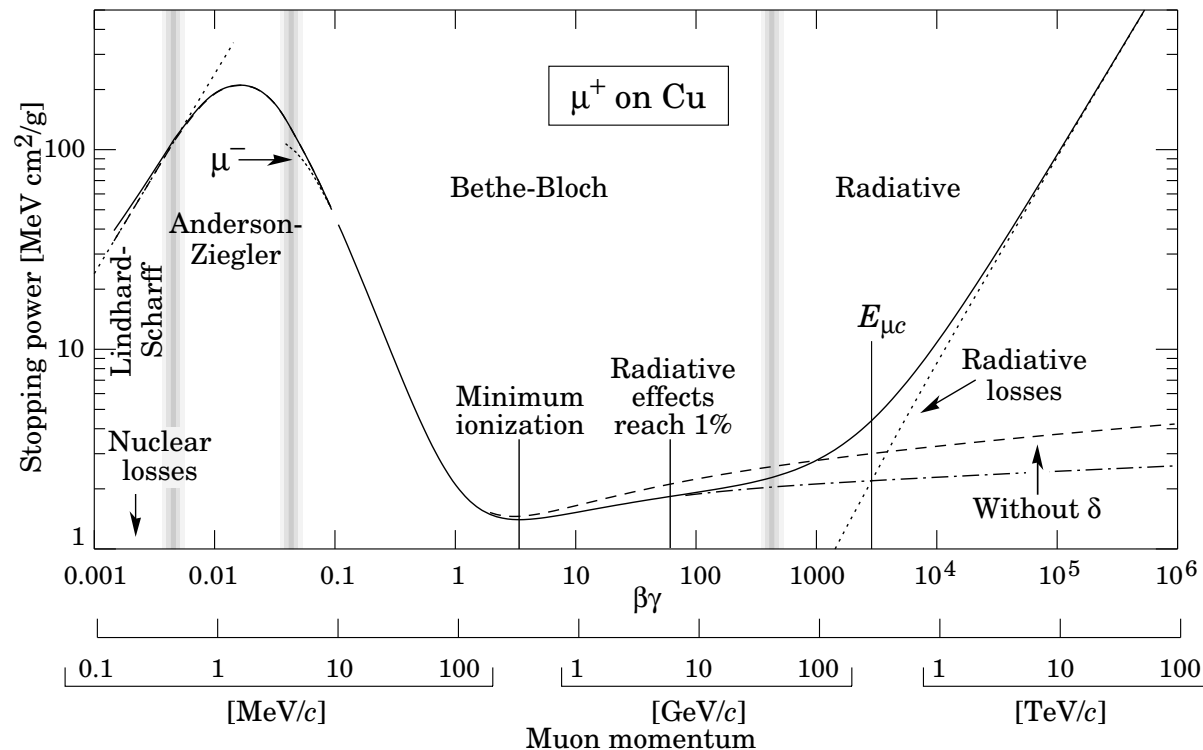
- Introduction
- Motivation
- Vertical Focusing
 - Vertical Position
 - Angle
- Summary and Plan

Introduction

- Don Summers describes some good idea regarding Muon Ring as an Anti-Cyclotron
- The idea is to cool muon beam based on Anti-Cyclotron technique
- We are working on the Anti-Cyclotron based on GEANT package simulation
- This Muon Ring is a gas filled ring with a simple geometry to begin with
- Please see Don's talk for more detail

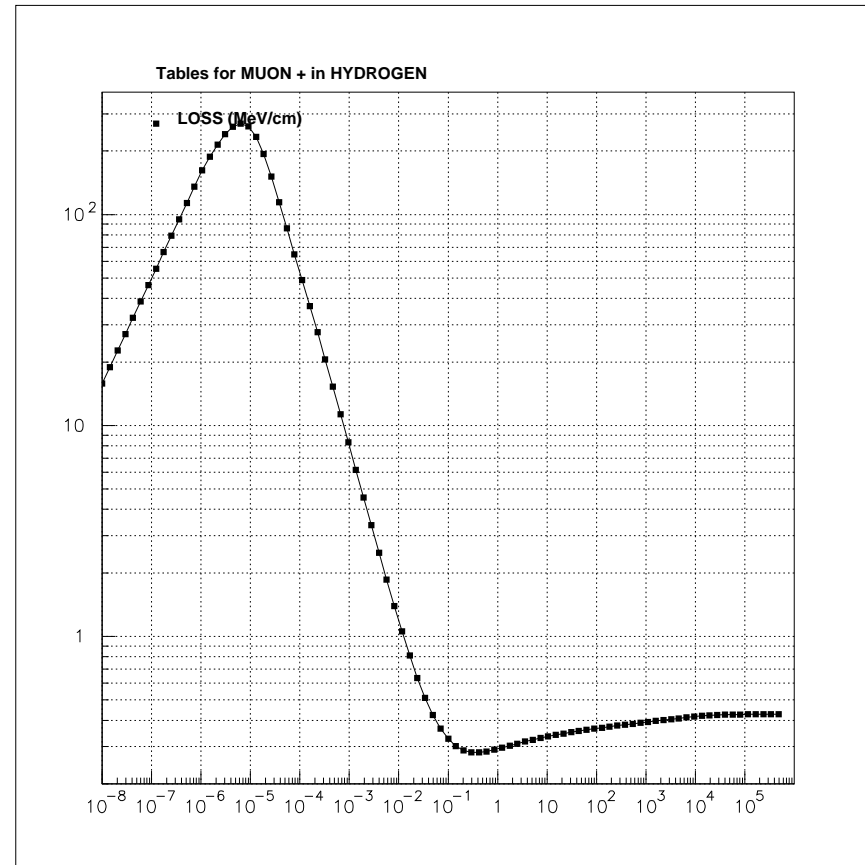
Motivation

- We are dealing with a low energy muon (\approx few keV).
The first question we asked ourself :
Can GEANT simulate in a low energy region ?
- A kinetic energy cut for muon in GEANT is 10 MeV.
We lower this threshold cut to 10 keV



dE/dx in GEANT

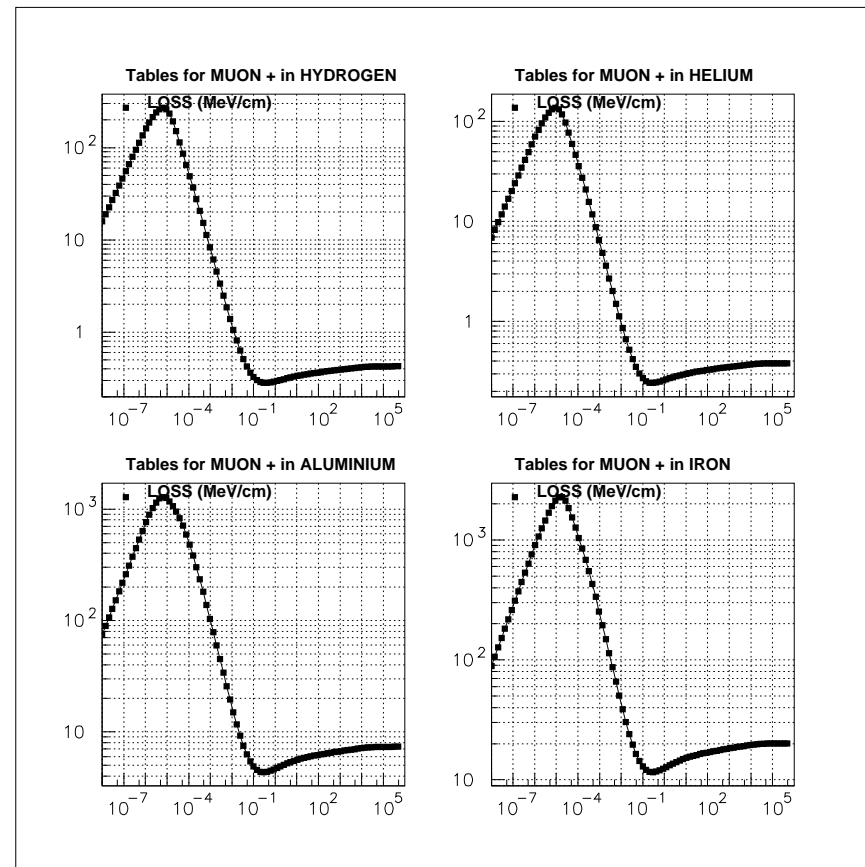
- We check muon physics processes in low energy region



- The dE/dx in GEANT matches well with the models

dE/dx in Other Media

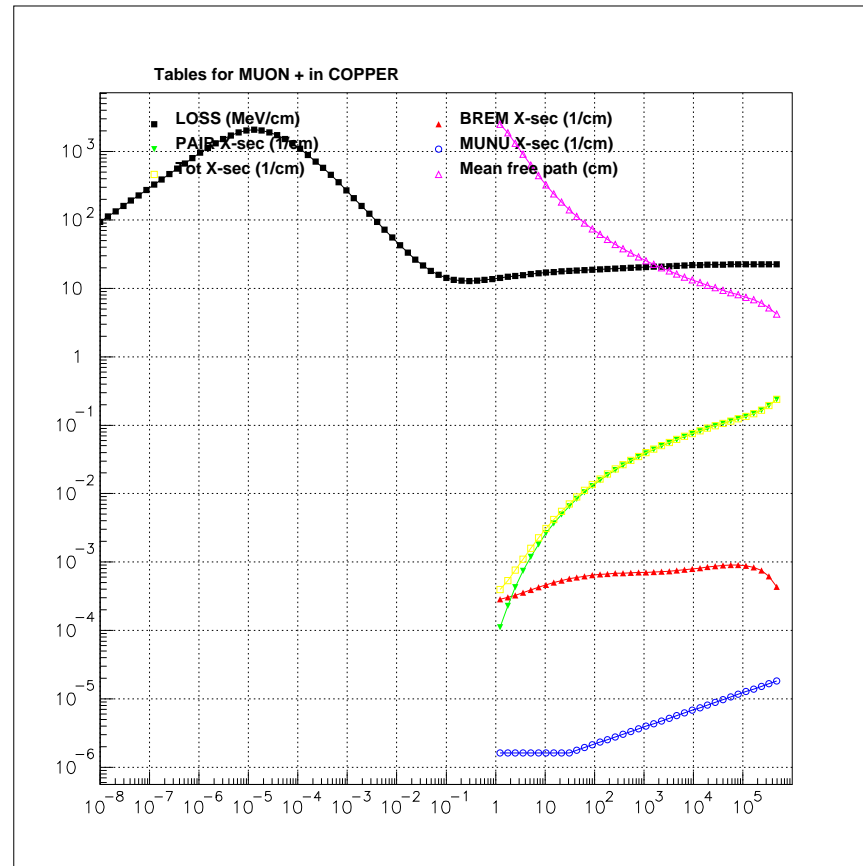
- We also check muon physics processes in other media



- GEANT is a good simulation package for doing physics processes in low energy region

Physics Processes in GEANT

- We also check all physics processes in low energy region



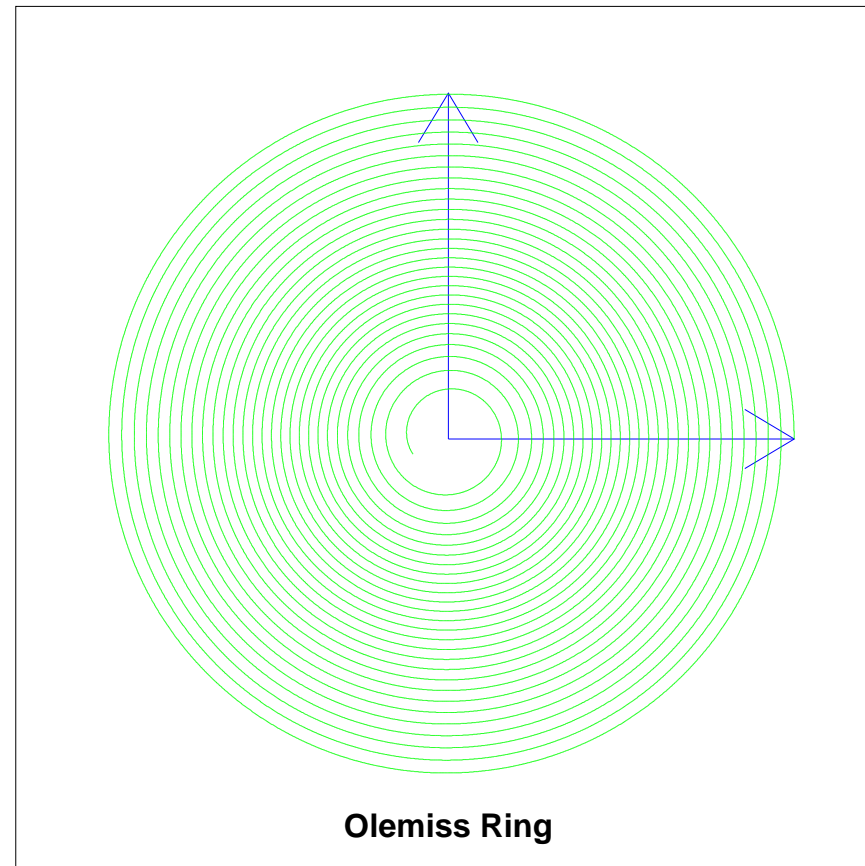
- This shows us that GEANT can do a good job in the low energy region

Anti-Cyclotron Parameters

- **Geometry:**
 - Cylindrical tube filled with Hydrogen gas
 - Radius = 100 cm
 - Thickness = 40 cm
 - Gas density = 50 atm
- $B_y = 1$ Tesla
- $B_x = (y/5) \sin \theta$
- $B_z = (y/5) \cos \theta$
- Muon momentum = 300 MeV/c

Top View

- We inject a muon with $P = 300 \text{ MeV}/c$ transversely

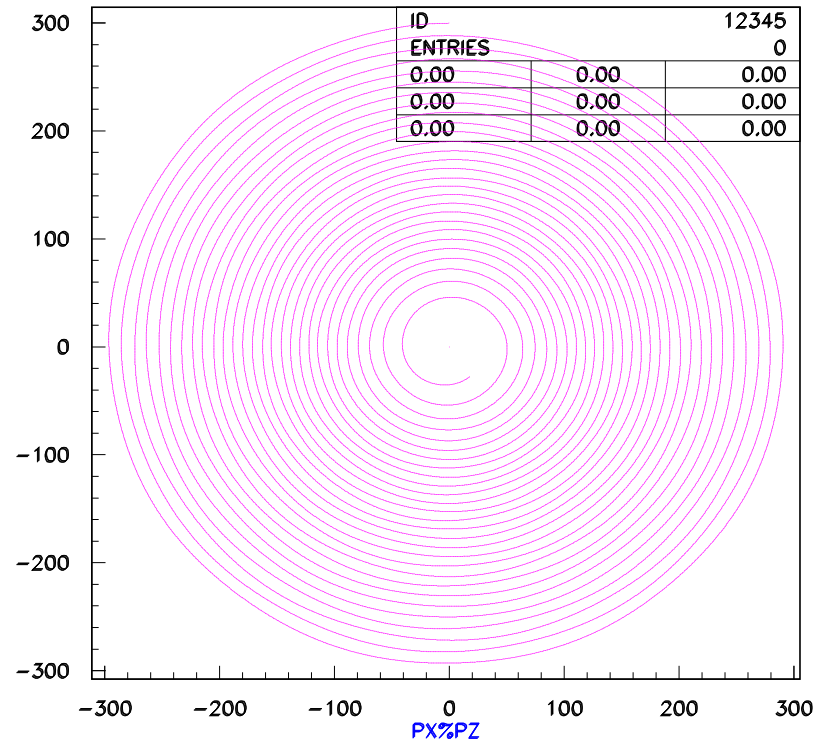


- Physics process is dE/dx only at the moment

Vertical Focusing

- We inject a muon at 2 cm above horizontal plane with $P = 300 \text{ MeV}/c$

2004/06/18 13.52

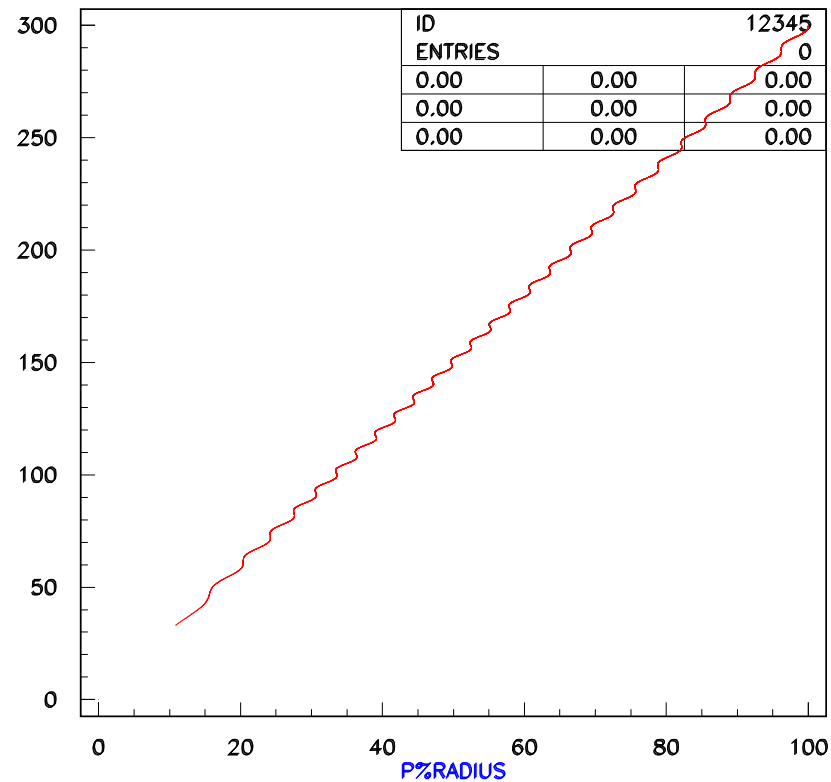


- It is due to the constant longitudinal field

Vertical Focusing

- Total momentum vs radius

2004/06/18 13.52

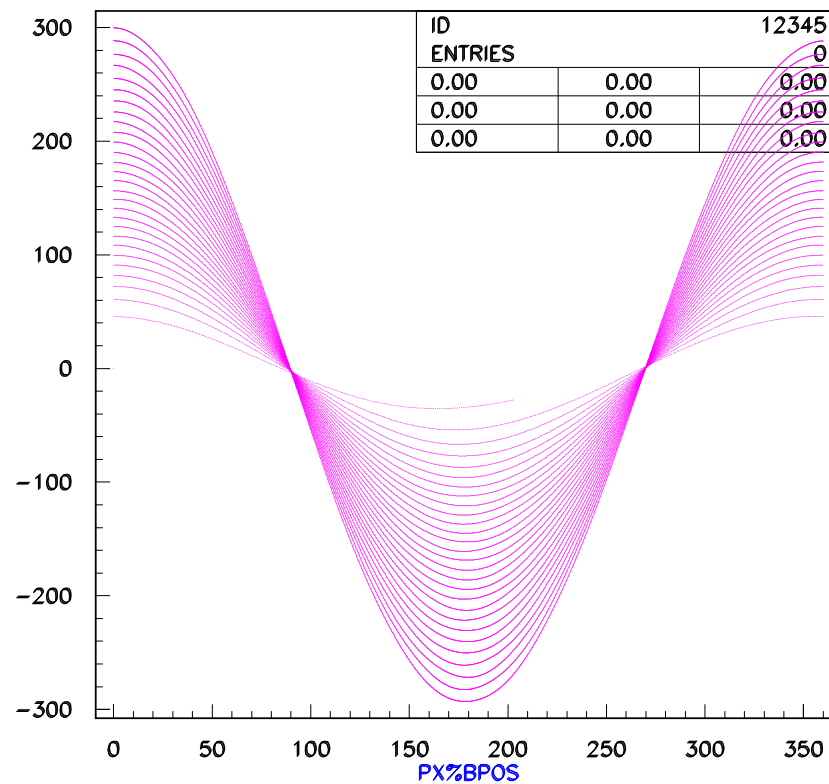


- The energy loss rate is higher toward the center

Vertical Focusing

- Px vs its position in the ring

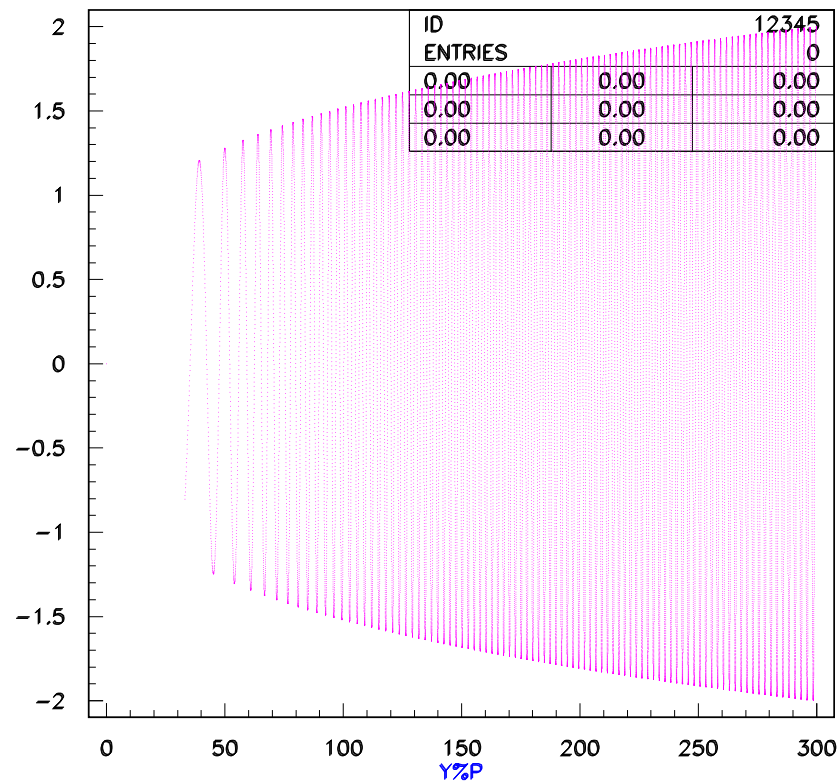
2004/06/18 13.52



Vertical Focusing

- Vertical position

2004/06/18 13.52

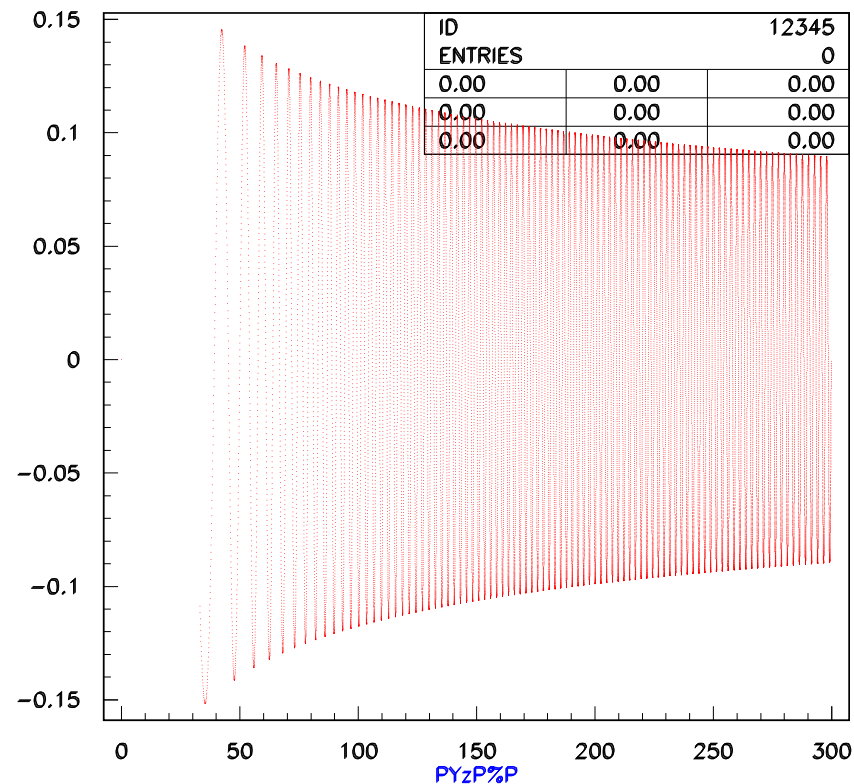


- Its vertical position is decreased by 60%

Vertical Focusing

- Vertical angle

2004/06/18 13.52

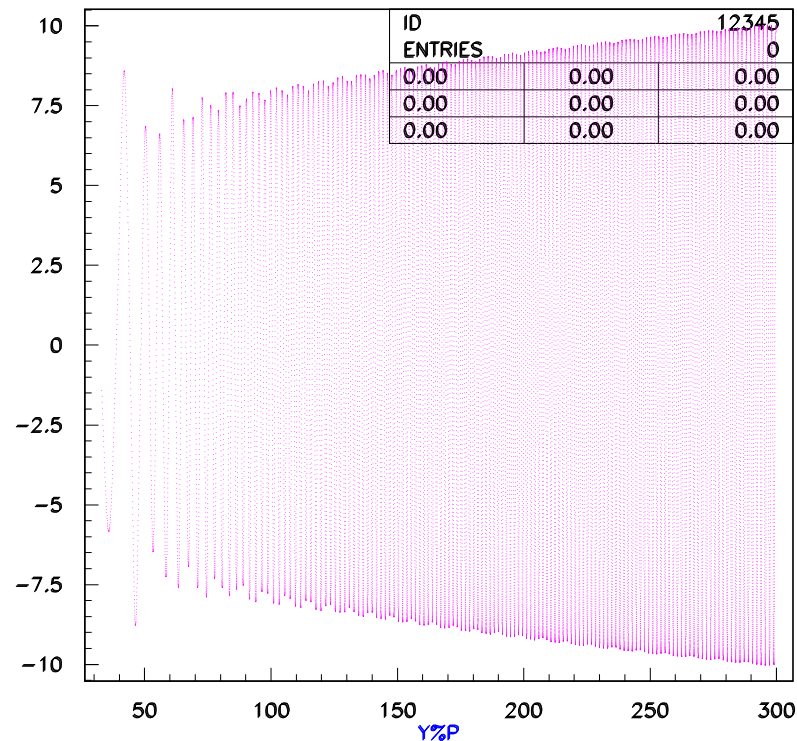


- Its angle is increased $< 60\%$

Vertical Focusing

- We inject a muon at 10 cm above horizontal plane with $P = 300 \text{ MeV}/c$

2004/06/17 19.20

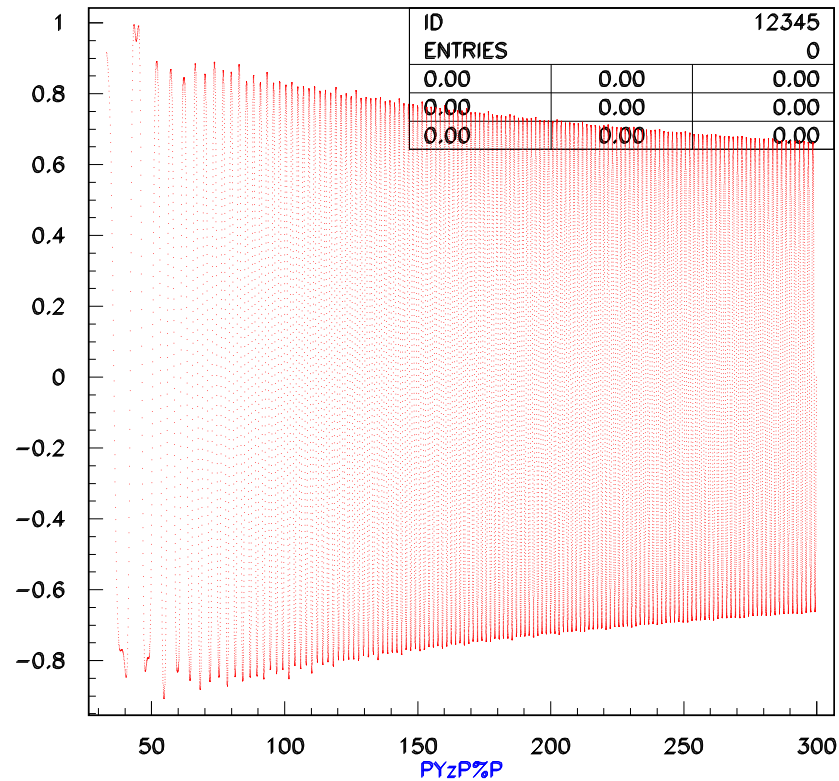


- Its vertical position is decreased by 60%

Vertical Focusing

- Vertical angle of 10 cm

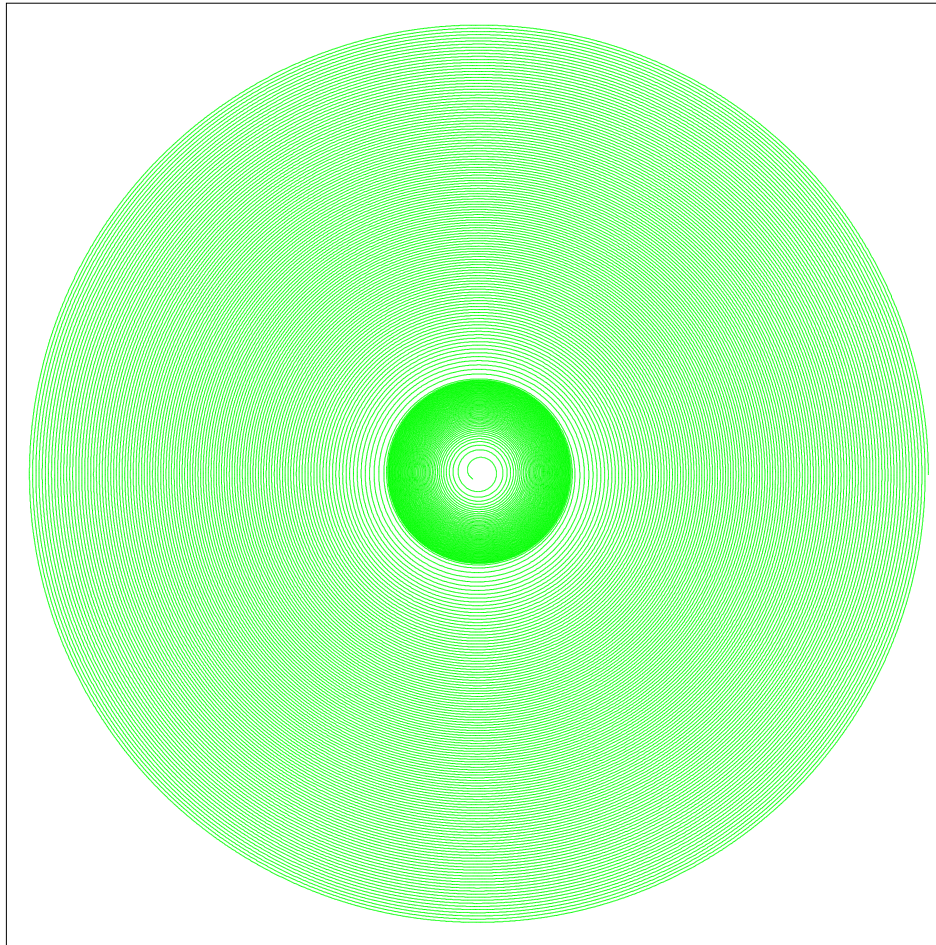
2004/06/17 19.20



- Its angle is increased $< 60\%$

Different Gas

- dE/dx with different gas density



Summary and Plan To Do

- GEANT is doing a good job for simulating particle in a very low energy region (few keV)
- The Anti-Cyclotron is a simple tool as a muon ring
- The vertical position is decreased by 60%
- The angle is increased $< 60\%$
- Need to study an appropriate magnetic field
- Need to apply a muon beam
- We are working on a dE/dx injection